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VARIATION OF THE DEER-MOUSE (*PEROMYSCUS MANICULATUS*) IN A MOUNTAINOUS AREA OF SOUTHERN NEW MEXICO

By Lee R. Dice

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INTRODUCTION

This study is of importance chiefly in showing the variability in several dimensions of the body and skeleton and in pelage color of a single subspecies of deer-mouse (*Peromyscus maniculatus rufinus*) within a small geographical area having a moderate amount of diversity in habitat types. The area studied lies in the mountains of Lincoln and Otero counties, southern New Mexico.

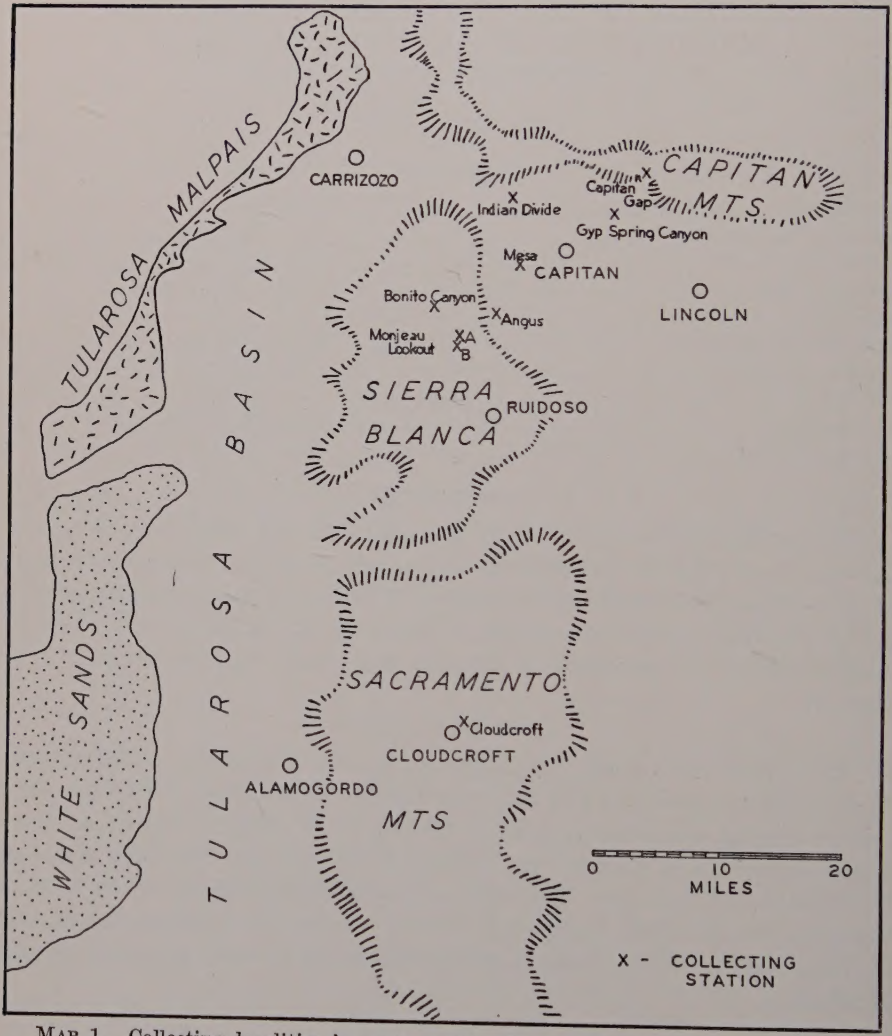
ACKNOWLEDGMENTS

The Cloudcroft stock was captured by the University of Michigan–Walker–Harris expedition of 1927 sent out by the Museum of Zoology. The Bonito Canyon stock was secured in 1928 by G. W. Bradt while on an expedition supported in part by the William P. Harris, Jr., Research Fund of the Museum of Zoology. The other stocks were secured by me in 1937 in connection with a field study supported in part by the Carnegie Institution of Washington. Most of the statistical calculations were made by Donald M. Clarke.

METHODS OF STUDY

The methods of study employed are the same as in my previous investigations of variation in *Peromyscus* (Dice, 1932). All of the animals here described were born in the laboratory and reared under nearly uniform conditions. All are of the one-year age class, and when killed for measurement were between the ages of thirty-six and seventy-eight weeks.

In the statistical comparisons between the stocks any difference between means greater than about 2.7 times its standard error has been considered to be significant. In the comparisons I have sometimes utilized also the standard deviations, making use of the fact that a difference between two means greater than the sum of their respective standard deviations indicates an overlap in measurements by less than 16 per cent of the individuals of the two populations concerned (Hubbs and Perlmutter, 1942).



MAP 1. Collecting localities in parts of Lincoln and Otero counties, southern New Mexico.

COLLECTING STATIONS

Most of the stocks of deer-mice here described were collected by me during the summer of 1937 (Dice, 1942). The stock from Cloudcroft was, however, collected in 1927 and that from Bonito Canyon in 1928. Measurements of the Bonito Canyon and Cloudcroft stocks have previously been published (Dice, 1933*a*). The stocks were secured at the following stations:

Angus. One and one-half miles northwest of Angus and nine miles in a direct line north of Ruidoso. Taken in yellow pine association at 7000 feet elevation.

Bonito Canyon. In the canyon of the Rio Bonito, twelve miles northwest of Ruidoso. Taken in meadows that were probably farm clearings, between 8000 and 9000 feet. The locality is now covered by the impounded waters above Bonito Dam.

Capitan Gap. On the south side of Capitan Gap, seven to eight miles in a direct line northeast of Capitan. In pinyon-juniper and yellow pine associations at 7000 to 7500 feet.

Cloudcroft. Within a mile of Cloudcroft. Taken mostly in Douglas fir association above 8000 feet.

Gyp Spring Canyon. Near Gyp Spring Canyon, four miles in a direct line northeast of Capitan. In short-grass association at 6200 feet.

Indian Divide. Just east of Indian Divide and six miles northwest of Capitan. In pinyon-juniper association at 7000 feet.

Mesa. Five miles southwest of Capitan. In pinyon-juniper association at 7000 feet.

Monjeau Lookout A. One-half mile southeast of Monjeau Lookout and seven miles northwest of Ruidoso. In oak brush association on a ridge at 9200 feet.

Monjeau Lookout B. One mile southeast of Monjeau Lookout and six and one-half miles northwest of Ruidoso. In yellow pine association at 8900 feet.

All these collecting stations are in Lincoln County, New Mexico, except the Cloudcroft station, which is in Otero County.

TABLE I

COLOR OF SURFACE SOILS FROM NEW MEXICO

Mean of ten tint photometer readings of each soil sample, in per cent

Station	Red	Green	Blue-violet
Angus	17.6	12.1	9.6
Capitan Gap	12.5	9.5	7.6
Gyp Spring Canyon	15.8	11.5	9.1
Indian Divide	20.4	14.8	12.5
Mesa	13.7	10.2	8.2
Monjeau Lookout A	18.3	12.4	10.6
Monjeau Lookout B	13.4	9.8	7.7

SOIL COLORS

The colors of the surface soils have been measured from a single sample taken at each of the collecting stations (Table I). No soil samples have been available from the Cloudcroft nor Bonito Canyon stations.

TABLE II

Measurements of *Peromyscus maniculatus rufinus* from New Mexico

Means, standard errors, and standard deviations for one-year age class, both sexes, in millimeters

Stock	Number	Mean Age in Weeks	No. of Parents	Body Length	Tail Length	Foot Length	Ear Length
Angus	60	48	10	96.68 ± .48 (3.77)	64.61 ± .53 (4.16)	20.763 ± .081 (.646)	18.964 ± .073 (.580)
Bonito Canyon	75	44	13	92.40 ± .45 (3.87)	66.55 ± .52 (4.51)	20.175 ± .087 (.746)	18.032 ± .091 (.789)
Capitan Gap	98	53	12	97.24 ± .47 (4.67)	63.16 ± .35 (3.44)	20.217 ± .063 (.623)	18.406 ± .083 (.824)
Cloudcroft	128	47	32	86.60 ± .37 (4.17)	70.25 ± .45 (4.98)	20.171 ± .065 (.736)	18.376 ± .070 (.782)
Gyp Spring Canyon	115	57	14	98.41 ± .41 (4.43)	66.42 ± .41 (4.42)	20.444 ± .061 (.656)	18.569 ± .067 (.710)
Indian Divide	60	55	12	95.28 ± .55 (4.23)	62.90 ± .49 (3.72)	20.377 ± .097 (.751)	18.502 ± .094 (.700)
Mesa	54	49	11	95.48 ± .45 (3.29)	66.80 ± .48 (3.49)	20.433 ± .074 (.547)	18.635 ± .086 (.632)
Monjeau Lookout A	77	56	12	96.99 ± .47 (4.12)	63.08 ± .44 (3.87)	20.155 ± .108 (.947)	18.514 ± .084 (.719)
Monjeau Lookout B	81	53	15	96.16 ± .48 (4.29)	63.54 ± .40 (3.55)	20.096 ± .074 (.664)	18.267 ± .087 (.783)

Stock	Femur	Mandible	Condyle-premaxilla	Condyle-zygoma	Bullar Width
Angus	16.268 ± .083 (.635)	16.217 ± .052 (.397)	24.659 ± .074 (.567)	17.592 ± .053 (.405)	10.932 ± .035 (.268)
Bonito Canyon	16.005 ± .070 (.553)	16.054 ± .052 (.431)	24.328 ± .079 (.639)	17.258 ± .059 (.474)	10.794 ± .034 (.276)
Capitan Gap	16.480 ± .064 (.615)	16.341 ± .040 (.385)	24.678 ± .062 (.604)	17.685 ± .041 (.399)	10.982 ± .034 (.330)
Cloudcroft	15.728 ± .064 (.693)	16.087 ± .041 (.442)	24.403 ± .065 (.671)	17.298 ± .041 (.430)	10.784 ± .024 (.255)
Gyp Spring Canyon	16.704 ± .069 (.733)	16.450 ± .044 (.471)	24.914 ± .070 (.740)	17.788 ± .044 (.465)	10.978 ± .030 (.318)
Indian Divide	16.130 ± .107 (.790)	16.116 ± .061 (.452)	24.275 ± .094 (.704)	17.298 ± .073 (.544)	10.822 ± .040 (.298)
Mesa	15.927 ± .077 (.557)	16.346 ± .067 (.486)	24.585 ± .080 (.577)	17.588 ± .057 (.413)	10.958 ± .027 (.194)
Monjeau Lookout A	16.216 ± .092 (.803)	16.370 ± .055 (.483)	24.707 ± .084 (.734)	17.643 ± .062 (.540)	10.958 ± .034 (.297)
Monjeau Lookout B	16.031 ± .061 (.531)	16.152 ± .052 (.459)	24.372 ± .071 (.632)	17.454 ± .055 (.491)	10.773 ± .030 (.269)

The differences in surface soil color between the several stations are moderate in amount. The soil at none of the collecting localities is either exceptionally dark or exceptionally pale.

VARIATION IN DIMENSIONS

Each of the stocks here described exhibits a moderate amount of variability in the dimensions of the body and of the skeleton, as measured by the magnitude of their standard deviations (Table II).

None of the stocks are consistently either very large or very small in their dimensions when compared with the other stocks from this region. The means of the several measurements differ between the stocks, and certain of the differences are of high statistical significance when evaluated by their standard errors. The magnitude of the differences in means is, however, usually not very great. The difference in mean condylo-premaxillary skull length between the Gyp Spring Canyon and Indian Divide stocks, for instance, is 0.639 ± .117 millimeter. This is one of the largest differences in skeletal measurements. In body length the Cloudcroft stock averages small, and its mean is exceeded by the means of all the other stocks, except the one from Bonito Canyon, by amounts greater than the sums of the two respective standard deviations. The difference in mean body lengths between the Gyp Spring Canyon stock, which is the largest in this dimension, and the Cloudcroft stock is 11.81 ± .55 millimeters. The sum of the two standard deviations is 8.60 millimeters. None of the other differences between the stocks in the mean measurements of either the body or the skeleton are as great as the sum of the two respective standard deviations.

VARIATION IN PELAGE COLOR

A moderate amount of variation in pelage color is present in nearly every one of these laboratory-bred stocks. The usual range of variation is from a dull buff to a dull gray. In the Capitan Gap stock a few specimens are bright buff and a few others gray, similar, respectively, to the buff and gray color phases of *blandus* (Dice, 1933*b*). Most of the Capitan Gap specimens, however, are intermediate in hue between buff and gray, and no separation of the stock into buff and gray phases is possible.

The palest pelage colors among the mice here described are exhibited by the stocks from Gyp Spring Canyon and Capitan Gap (Table III). These stocks rank high in tint photometer readings both for the dorsal stripe and the side of the body. The Gyp Spring Canyon stock is significantly exceeded by the Capitan Gap stock only in readings for dorsal stripe blue-violet.

The Indian Divide stock ranks high in tint photometer readings for dorsal stripe red and green, but in the other color readings it is intermediate among the stocks. The Mesa, Angus, and Monjeau Lookout A stocks rank intermediate among the stocks in all the color readings.

The Cloudcroft stock has significantly lower tint photometer readings for the dorsal stripe than has any other stock from this region. It ranks low also in the readings for side green and side blue-violet, but it significantly exceeds the Monjeau Lookout B stock in readings for side red.

The Monjeau Lookout B stock has significantly lower readings for side red than has any other stock. Its readings for side green and side blue-violet also rank low. In the readings of the dorsal stripe, however, it has significantly higher readings than has the Cloudcroft stock.

The Bonito Canyon mice also have relatively dark pelage colors. For the readings of the dorsal stripe they significantly exceed only the Cloudcroft mice; in the readings for side green and side blue-violet they significantly exceed only the Cloudcroft and Monjeau Lookout B mice; but their readings for side red are high, for these average significantly lower only than those of the Gyp Spring Canyon mice.

TABLE III

PELAGE COLOR OF *Peromyscus maniculatus rufinus* FROM NEW MEXICO
Mean tint photometer readings, standard errors, and standard deviations for one-year age class, both sexes, in per cent

Stock	Dorsal Stripe		
	Red	Green	Blue-violet
Angus	10.00 ± .16 (1.28)	7.34 ± .12 (0.96)	5.23 ± .10 (0.77)
Bonito Canyon	9.29 ± .21 (1.66)	5.97 ± .17 (1.34)	4.66 ± .12 (1.00)
Capitan Gap	11.57 ± .20 (1.90)	8.77 ± .17 (1.53)	6.93 ± .14 (1.29)
Cloudcroft	7.90 ± .11 (1.29)	5.12 ± .06 (0.76)	4.01 ± .05 (0.61)
Gyp Spring Canyon	11.54 ± .16 (1.62)	8.53 ± .11 (1.10)	6.38 ± .09 (0.94)
Indian Divide	11.40 ± .28 (2.13)	8.48 ± .19 (1.49)	6.20 ± .16 (1.20)
Mesa	10.42 ± .17 (1.33)	8.02 ± .13 (1.00)	6.29 ± .14 (1.04)
Monjeau Lookout A	9.99 ± .16 (1.38)	7.68 ± .13 (1.13)	6.01 ± .10 (0.91)
Monjeau Lookout B	8.62 ± .17 (1.48)	6.42 ± .14 (1.20)	4.81 ± .10 (0.90)
	Side Stripe		
Angus	18.70 ±. 24 (1.89)	13.36 ± .20 (1.58)	9.67 ± .14 (1.16)
Bonito Canyon	20.41 ± .30 (2.38)	12.92 ± .21 (1.66)	9.58 ± .20 (1.60)
Capitan Gap	20.93 ± .25 (2.32)	15.43 ± .19 (1.79)	11.84 ± .17 (1.53)
Cloudcroft	19.50 ± .19 (2.24)	12.14 ± .12 (1.48)	8.83 ± .10 (1.15)
Gyp Spring Canyon	21.74 ± .27 (2.67)	15.80 ± .18 (1.79)	11.44 ± .14 (1.38)
Indian Divide	20.20 ± .34 (2.59)	14.60 ± .23 (1.78)	10.72 ± .19 (1.43)
Mesa	19.81 ± .28 (2.12)	14.48 ± .21 (1.62)	10.78 ± .18 (1.40)
Monjeau Lookout A	19.13 ± .25 (2.23)	14.08 ± .20 (1.81)	10.65 ± .18 (1.57)
Monjeau Lookout B	15.99 ± .33 (2.94)	11.49 ± .25 (2.19)	8.38 ± .18 (1.63)

When comparisons between these stocks are evaluated by means of the standard deviations it is evident that the means of the tint photometer readings of the dorsal stripe for all three color screens are lower for the Cloudcroft stock than are those of the stocks from Capitan Gap, Gyp Spring Canyon, and Indian Divide. The difference in each comparison is greater than the sum of the two respective standard deviations. For dorsal stripe green and blue-violet the differences between the Cloudcroft and the Mesa and Monjeau Lookout A means also are greater than the sums of the two respective standard deviations. For dorsal stripe green, furthermore, the Cloudcroft mean is less than the Angus mean by an amount that is greater than the sum of the two respective standard deviations.

In tint photometer readings of the side stripe the mean of the Gyp Spring Canyon stock for red is higher than that of the Monjeau Lookout B stock by an amount greater than the sum of the two respective standard deviations. In readings for side stripe green the Gyp Spring Canyon stock exceeds the Cloudcroft and Monjeau Lookout B stocks, and the Capitan Gap stock exceeds the Cloudcroft stock, by amounts greater than the sums of the respective standard deviations. In readings for side blue-violet the Capitan Gap and Gyp Spring Canyon stocks both exceed the Cloudcroft and Monjeau Lookout B stocks by amounts greater than the sums of the respective standard deviations. No other differences in color readings as great as this are exhibited by any other of the stocks.

It is evident therefore that of the stocks here compared the palest in pelage are those from Gyp Spring Canyon and Capitan Gap. The Cloudcroft and Monjeau Lookout B stocks have the darkest colors. Some of the differences between the stocks are of considerable statistical significance, though none are very great in amount. The difference in mean tint photometer readings for dorsal stripe red between the Capitan Gap and Cloudcroft stocks is 3.67 ± .23 units. The mean difference for side stripe red readings between the Gyp Spring Canyon and Monjeau Lookout B stocks is 5.75 ± .43 units. These are the greatest differences between any of the stocks.

DISCUSSION

The statistical comparisons that have been made in this report apply, of course, only to the laboratory-bred stocks and not to the wild populations living at the localities where the parents of the laboratory stocks were collected (Hovanitz, 1942: 179–81). Any group of individuals captured at a particular station which becomes the parents of a laboratory stock will carry an inadequate sample of the genes of the whole wild population. There is no way of estimating how adequate each sample is. Nevertheless, the measurements of the laboratory stocks do give an indication of the characters of the wild populations and of their variabilities. Series of *Peromyscus* taken in the field have shown general agreement in measurements with series bred in the laboratory (Dice, 1933*a*: 5–7; 1937: 10–17).

The collecting stations for the deer-mice described in this report are in the oak-brush, yellow pine, and Douglas fir associations of the montane belt and in the short-grass and pinyon-juniper associations of the sabinal belt (Dice, 1930 and 1942). The ecologic diversity between these stations is only moderate in amount. The patches of oak brush and of short grass in these belts are generally small in size, and most of the area of both the montane and sabinal belts is covered by more or less dense woodland or conifer forest. Elevations range from 6200 feet at Gyp Spring Canyon to 9200 feet at the Monjeau Lookout A station.

All the stations except the one at Cloudcroft lie within an area about twenty-five miles in greatest diameter. The Cloudcroft station lies about twenty-five miles farther south. None of the stations therefore are distant in a direct line from one another more than about fifty miles.

Within this relatively small area of moderate diversity in habitat types it is not surprising that no great variation in the body dimensions of the deer-mice is exhibited. The small differences in the dimensions of the body and its parts that do distinguish these several stocks may be in part due to errors in the sampling methods employed. It is probable, however, that there are some differences between the various local populations in the aggregate of genes that affect body size. There is no evidence that the differences in body dimensions between the several stocks are correlated in any way with differences between the types of environments at the several collecting stations.

The pelage color, as measured by the tint photometer, differs considerably among the stocks. Some of the differences between the stocks in pelage color might be expected to be correlated with differences in the heaviness of the vegetation and with the surface soil color at the collecting stations. Such correlations are known to exist in other regions (Dice and Blossom, 1937: 92–108).

A tendency toward a correlation between the darkness of pelage of the deer-mice and the heaviness of the vegetation at their collecting stations is especially suggested by certain of the stocks. The Cloudcroft and Monjeau Lookout B stocks have on the average the darkest pelage, and these stocks came from the heaviest conifer forests in the area. Conversely, the Gyp Spring Canyon stock, which averages pale in pelage, is from open short-grass association. The Capitan Gap stock, which also averages pale in pelage, came from moderately heavy pinyon-juniper and yellow pine forest. It should be pointed out, however, that the Capitan Gap and Gyp Spring Canyon localities lie immediately adjacent to one another and that the two collecting stations were less than three miles apart. The general rule that the pelage color of these mice tends to be dark in heavy forest and pale in open situations, seems therefore to be here modified locally by the influence of an adjacent community of contrasting ecologic type.

No close correlation between pelage color and soil color is evident among these stocks. It is true that the soil color at the Monjeau Lookout B station is relatively dark (Table I) and that the pelage color of the mice likewise averages dark. However, the soil at the Capitan Gap station is also dark, and the mice of that stock average pale in pelage. Further, the Gyp Spring Canyon mice average pale in pelage, and the soil at their collecting station ranks intermediate.

When considering the general tendency toward a correlation between the pelage color of the deer-mice and the heaviness of the vegetation and the apparent absence of a correlation between pelage color and surface soil color, it should be borne in mind that in this small region there is a considerable variety of vegetation, but no strong variation in soil color. Furthermore, it must be remembered that all these collecting stations are fairly close together. There are no evident barriers here to the movements of the deer-mice, and these highly mobile mammals undoubtedly at times move considerable distances. It would be expected, therefore, that there would be considerable interbreeding between the various local populations. This interbreeding would theoretically tend to prevent the production of strongly marked local races.

Nevertheless, the evidence from the laboratory-bred stocks indicates that some of the local wild populations differ from others in certain average characters. Some of the variations in pelage color among the stocks tend to be correlated with variations in the types of vegetation growing at the several collecting stations. Many of the differences between the stocks have, on the contrary, no obvious ecologic relationship and probably indicate only the presence of random local variations in the hereditary constitutions of the several wild populations. The precise amount of difference in genetic constitution between the various local wild populations cannot, however, be measured by the data here presented, because of the errors of sampling involved in the production of the laboratory-bred stocks.

SUMMARY

Measures of the body and skeletal dimensions and of pelage color are given for nine laboratory-bred stocks of deer-mice from a small area in the mountains of southern New Mexico, where there is a moderate amount of habitat variability. Some of the differences between the means of the several stocks are of high statistical probability, though none are very great in amount. There are greater differences between the stocks in pelage color than in body dimensions. Insofar as the laboratory-bred stocks represent the characters of the wild populations at the places where their parents were trapped, there is an indication that the depth of pelage color of the deer-mice tends to be correlated with the heaviness of vegetation in their habitats. No other ecologic trend is apparent. Some of the differences between the stocks are presumably due to random variations in genetic constitution between the local wild populations inhabiting the various parts of the area studied.

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